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## CS485 AUTONOMOUS ROBOTICS

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### Homework 4 Robot Perception

**Due:** April 28 before class

**Name:**

**G Number:**

**Email:**

## 1 Motion Model

What is the robot motion model? Please write out the mathematical formulation and explain your notations. Note that robot motion model should also include the action (or odometry) taken by the robot. (10 points)

Why do we need a probabilistic robot motion model? List a few examples why the model is not deterministic for a wheeled mobile robot moving in the real world. (5 points)

## 2 Sensor Model

What is the robot sensor model? Please write out the mathematical formulation and explain your notations. (10 points)

What are the factors that need to be considered for a beam-based proximity sensor model? Please list all the factors, explain each of them, and sketch out the final probability distribution function of the final sensor model. (10 points)

### 3 Discrete Filter Algorithms

Briefly explain how Discrete Bayes Filter works. (10 points)

What is the advantage of Particle Filter over Discrete Bayes Filter? (10 points)

What is a practical technique to address the “kidnapped robot” problem, when using Particle Filter? (5 points)

## 4 Least Square Solving and RANSAC

Formulate the least square problem using matrix form and illustrate your notations in a sketch. (10 points)

Why do we sometimes need pseudo-inverse to solve the least square problem? When is pseudo-inverse not needed? (10 points)

What is the general procedure of RANSAC? (10 points)

If we choose  $s$  samples per round, we have an outlier ratio  $e$ , and we want to get the right RANSAC result with probability  $p$ , how many times  $N$  should we iterate to perform RANSAC? (10 points, you may need to refer to the textbook or slides we haven't covered during the lecture.)